RCA

electronic age

AUTUMN 1962

STYLING IN THE 60'S

RCA electronic age

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COVER: *T. P. Madawick (r.), Manager, Industrial Design, RCA Service Co., and staff (l. to r.): H. T. Lay; H. M. Jaeger; and L. M. Knight, rolled up their shirtsleeves to show off some of the new RCA Victor home instruments for 1963. For the story of style, see page 2.*

In this issue . . .

RADIO CORPORATION OF AMERICA
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

DAVID SARNOFF, *Chairman of the Board*, ELMER W. ENGSTROM, *President*,
FRANK M. FOLSOM, *Chairman, Executive Committee*,
JOHN Q. CANNON, *Secretary*, ERNEST B. GORIN, *Treasurer*

Dr. Elmer W. Engstrom, RCA President, displays one of the cameras carried by the RCA-built TIROS weather satellites, which have now achieved a remarkable 100 per-cent success in six consecutive launchings.

Styling in the 60's

by Eleanor Adams

IT'S NOT ONLY FASHIONABLE to be slim these days, it's more comfortable. We've become a diet conscious nation primarily, to fit the space we're obliged to live in — and the furniture designed for it. In home furnishings the lean look gives our smaller living quarters the feeling of spaciousness.

Furniture has been scaled down. The bulky pieces which were popular in Grandma's day are as obsolete as her horse-drawn carriage. Everything in the house from the kitchen range to the living room sofa has been trimmed and slimmed. Home entertainment products are no exception.

Portable TV sets are smaller and lighter; consoles are lengthening horizontally but are notably closer to the floor and thinner. There's no longer a question of the TV or stereo console being "furniture-styled." It now has all the intrinsic values of fine furniture, beauty of wood, beauty of design and detail plus real utility.

One of the newer and most popular cabinet designs is the two-tiered hutch, first introduced by RCA this past year and to be continued in 1963. Whether it's housing a stereo system or a complete entertainment center, it's a compact, attractive and useful piece of furniture. It's not sheer flattery that the design is now being copied by others.

In describing the new stereo "Victrola" phonograph consoles, Bryce S. Durant, RCA Sales Corporation Vice President, Product Planning and Development, said, "Due to the continued consumer demand for the Danish Modern, French provincial and early American 'hutch' cabinets, they will remain at the top of our 1963 line with technical modifications." This year RCA's variation of the "hutch" is the new "spinet" cabinetry, which turns up in both stereo consoles and a home entertainment center.

Color, of course, is a prime contributor to decor. Do you remember when telephones first burst into flaming red or petal pink? Now, in your bedroom, you can have your phone, clock-radio and portable TV all in matching white or pastel shades.

One appliance maker has recently introduced an early American theme in a built-in gas range, dishwasher and surface units. All three incorporate an American eagle symbol in their design; all three are in coppertone, which is described as "a color identified with early American motifs"; the oven has hard maple door handles; and the range clock is copied after an early grandfather clock.

Furniture looks as if it will be around for a while, although there are two noteworthy trends. One is the tendency to hang more and more things on floor-to-ceiling poles — lamps, bookcases, shelves of all kinds, cabinets, room dividers, television sets. (The forerunner of this was probably designer George Nelson's first storage wall back in the '40's. Mr. Nelson, who says he hopes to eliminate furniture altogether, was a pioneer in spatial thinking.)

The other trend is to put something on or in the wall. At the recent Music Show there were more on-the-wall portable phonographs with drop-down turntables. Two years ago RCA showed a television set built into a picture frame which could be hidden by a rolling shade. One hi-fi expert is predicting that by 1965 the pictures that decorate your wall will be piped with sound. "The new stereo speakers," he says, "will be thin and comparatively small."

It's only a step from that to what Tucker P. Madawick, Manager, Industrial Design for the RCA Sales Corporation, foresees in his own crystal ball. Admitting that "we've learned to anticipate furniture trends," Mr. Madawick suggests that eventually home entertainment instruments will have a shape all their own and will move more toward the personal-use-portable-type set instead of the home entertainment center completely out of sight with slave units throughout the house.

"The large-picture-on-the-wall-TV set may possibly replace the livingroom console as some people expect," he said. "However, we will always have individual differences in programming preferences among the various members of the family. There will be more and more personal viewing of television just as today there

Big-screen portability; styling mark RCA black-and-white sets.

is more and more personal listening to radio."

For that reason, says Mr. Madawick with a gleam in his eye, "I don't think the designer will ever be out of a job in our industry." In the meantime, however, he's still extremely busy designing for our lack-of-space age. ■

New color television receivers attract admiring glances at RCA Exhibition Hall.

NAPOLEON once stated figuratively that every soldier carried a field marshal's baton in his pack. He was, of course, referring to every soldier's ability to make fast combat command decisions. In today's U.S. Army that ability depends tremendously on electronic communications, so it can be said that the field marshal's baton has been replaced by efficient, reliable and portable communications devices.

This latest electronic ally of the foot-soldier in the field is a result of the U.S. Army's expansion in communications using RCA developed micromodules — an electronic development of tiny physical size, — but with immensely critical functions in battlefield communications and computations. These functions range from simple man-to-man communication to the urgent business of computing fire tables for artillery under fluid conditions.

Put simply, a micromodule is a packaged circuit in which components or combinations of components are mounted on standard shape wafers. The heart of the micromodule concept is the rigid application of disciplined geometry to the design of all electronic components. The micromodule itself consists of a stack of thin, uniformly shaped, wafer-like components called microelements, which are interconnected by means of 12 wires attached around the periphery, and encapsulated to form a rugged compact module an amazing 0.360 inches square. Usually, such modules are designed to fall within a height range of .4 to .8 inches.

RCA's micromodule program with the Army has been a fairly long one culminating in a most successful marriage. As far back as October, 1957, RCA's Surface Communications Division demonstrated the micromodule concept to the Army with a fountain-pen radio set. Then in the spring of the following year, the Army awarded RCA a contract for approximately $5,000,000 covering the program as it exists today.

Early in 1959, RCA's Aerospace Communications and Controls Division in Burlington (Mass.) built the STABLE PLATFORM — an inertial guidance mechanism — using micromodules for electronic functions. Later that year, the Army increased the RCA contract to wider ranges of microelements; added new microelements; and raised temperature qualification requirements of certain microelements.

In 1960, the micromodule program was highlighted by:

• An Army contract to provide for design and construction of MICROPAC Computer and helmet radios as micromodule demonstration equipments and to implement production engineering phase of the program.

• RCA's anouncement of the availability of MICRO-MODULE Designer's Kit for making breadboard quantities of micromodules for on-the-spot assembly.

• A North American Aviation sub-contract to RCA Burlington for the U.S. Navy for Microdular Infra-Red Sensors.

• The evolution of a new microminiaturization transistor package.

Finally, at the end of the year, a contract reliability goal was surpassed and the Army authorized continuation of testing to determine actual reliability.

This year saw the expansion of the Army's program to provide for production engineering and implementation of additional manufacturing sources. As a result, the helmet radio design was accepted by the Army; the Army's Electronic Proving Ground gave a contract go-ahead to RCA for Micromodular Random Access FIELDATA Computer and the Army also accepted the MICROPAC Design. The Navy also awarded a contract to RCA for micromodularized computer test sets.

All this development program came when the Army announced in late summer that it planned a substantial expansion of its Micromodule Program, a move it called "rounding the marker from production engineering and launching into actual production."

The reason for the tremendous growth of interest in micromodules is the reliability, size, and realistic approach to equipment costs.

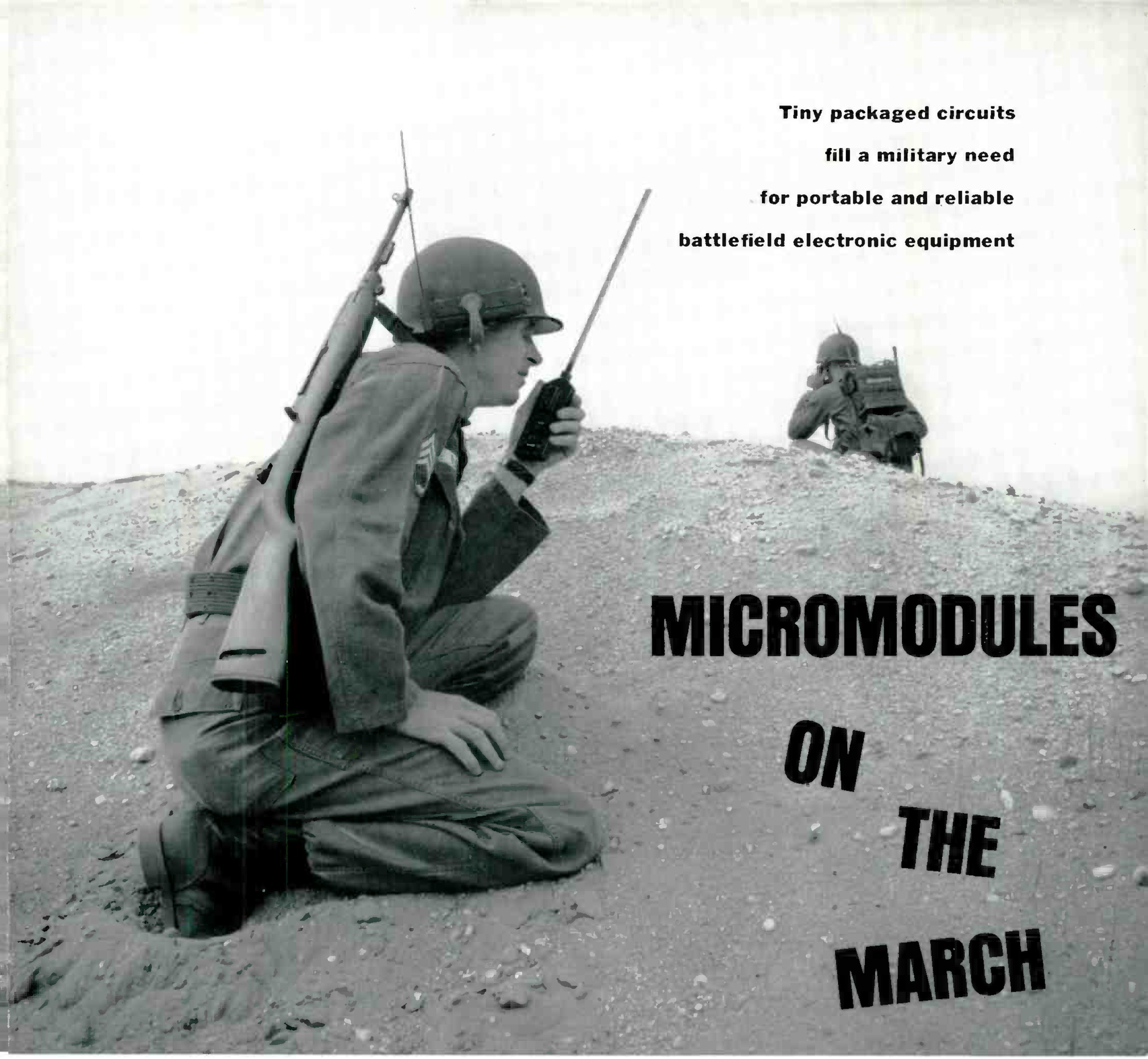
As measured by millions of hours of testing, the micromodule circuit has proved to be six times as reliable as conventional military electronic circuits and 60 times as reliable as equipment employing tubes. The high degree of micromodule reliability is the result of (1) the inherent characteristics of the micromodule itself; (2) maximum exploitation of the best materials available; (3) exploitation of the best processes; and (4) a rigidly applied reliability program.

The inherent characteristics of the micromodule construction supply its main reliability advantages in that micromodules have great adaptability to production and automation; they're mechanically rugged; they possess component compatability with circuit requirements and they reduce the amount of cabling, hardware and structural support requirements.

Besides the size advantages inherent in all miniaturization techniques, the rigid geometry of the micromodule permits extremely high-density electronic packaging. Two outstanding examples of this are the first two types of equipments developed: the steel-helmet radio, with 210,000 parts per cubic foot and the MICROPAC with 250,000 circuits parts per cubic foot. An even more dramatic illustration is the possibility of electronic packages of up to an amazing 600,000 parts per cubic foot, based on the uniformly square shape of micromodules.

Tiny packaged circuits fill a military need for portable and reliable battlefield electronic equipment

MICROMODULES ON THE MARCH



The Micromodule concept affects equipment costs both in initial costs (largely through mechanization and standardization and reduced supporting hardware) and reduced supporting costs in terms of maintenance and logistis.

A ten-part micromodule today costs $52.00 as opposed to $20.45 for a conventional printed-board solid-state circuit. However, prices being quoted now for delivery in 1963 and 1964 will approach, and even cross under, the price of conventional circuitry.

With increased production, the equipment costs will decline rapidly and will reach a point well below the costs of conventional circuit construction.

Assuming that 100 represents the initial cost in percentage of a conventional circuit then a micromodule costs 10 per cent more, or 110. Projecting this over a 10-year-life cost projection, equipment first costs (100), maintenance (144) and logistics (148) add up to 392 for the conventional circuit, but only to 290 total for the micromodule even though the equipment first cost of the micromodule was 10 per cent higher.

One of the major initial goals of the Micromodule

Program was the establishment of a broad industry-based production capability. A highlight of the production-engineering phase of the program has been the qualification of two additional suppliers of micromodules — P. R. Mallory & Co., Inc., of Indianapolis, and Paktron Division of Illinois Tool Works, Inc., of Alexandria, Va. The efforts of these two suppliers and those of RCA Semiconductor and Materials Division, Somerville, N. J., supported by more than 60 micro-element and materials suppliers, assure continuation of the program. Current examples of micromodule application include:

1. PRC-51 Helmet Radio
2. AN/TYK-9 MICROPAC Computer
3. United Aircraft Corporation Airborne for U. S. Air Force
4. Stable Platform Inertial Guidance Mechanism
5. North American Aviation Airborne Infra-Red Sensor for U. S. Navy
6. Mobile Random Access FIELDATA Computer for U. S. Army Electronic Proving Ground
7. Computer Test Set for U. S. Naval Electronic Laboratory
8. Hybrid Version AN/PRC-25 Back Pack Army Field Transceivers
9. Hybrid Version AN/PRC-10 Back Pack Army Field Transceivers

In a detailed progress report, both past and projected, Maj. Gen. Earle F. Cook, Chief Signal Officer, said recently the Micromodule Program has proved so successful that the Army's Deputy Chief of Staff for Logistics had issued a directive to "take prompt and positive action to incorporate the micromodule concept as appropriate."

"Since World War II", continued General Cook, "no other branch of the physical sciences has been the host to so many new advances as electronics. Among the major benchmarks in the way of parts, components and techniques you can count transistors, printed wiring, miniature tubes, and the more recent thin-film methods of depositing extremely thin layers of electronic materials on substrates."

"The result of all these and other advances is the vast expansion in electronic capabilities that has been making our accomplishments possible."

" But while increasing our capabilities, we have at the same time been witnessing a sort of paradox. This is a condition in which, because of their inventiveness, our engineers and scientists — in both government and industry — have produced a proliferation of divergent component shapes, sizes and functions. The sequence on more than one occasion is that our design people have found it necessary to conduct shotgun weddings of parts not altogether compatible."

And as systems have become more complex and capable, they also have become bigger and heavier. If this trend were allowed to continue unchecked, we might eventually find ourselves entering the dinosaur age of electronic equipment — a situation in which our equipment might become swamped because of outgrown size."

"What we needed was a fresh concept in electronics, a bold new departure that could meet our technical and tactical requirements for the future, and at a price we could afford. We wanted both a revolution and a consolidation that would shape the present capabilities of the electronic art into more coherent form, and at the same time give us the flexibility to absorb new advances in techniques as they occur."

"One critically important goal was to reduce the weight and size of components, sub-assemblies and equipment — the latter by a factor of ten or more."

"The object we conceived for accomplishing these rather formidable requirements was what became the micromodule."

General Cook made these points regarding the program's future:

1. The Army anticipates committing some $8 million for equipment and systems in fiscal year 1963 — about double the 1962 funding — and even more in 1964. Up to 1962, $18 million had already been invested in the program.
2. The Army-industry team conducting the program should achieve a production rate of 250,000 micromodules a year by March of 1963, a million a year by June of 1964 and three to five million sometime in 1965, under existing plans.

W. Walter Watts, Group Executive Vice President of RCA, stated that through the Micromodule Program enormous benefits can be foreseen for vital areas of America's space age thrust, as well as advances in the whole art and science of electronics.

"The micromodule concept," he said, "provides answers here and now to urgent military needs for smaller, lighter and more reliable electronic components, devices and systems. Moreover, because of its inherent flexibility to accept present and future micro-electronic techniques, the concept offers the electronics industry the most promising new horizon for expansion. While many other exciting techniques in micro-circuitry are being researched and talked about, micromodules can be and are being produced right now."

The impact of the Micromodule Program on the electronics industry was indicated by General Cook's mention of the fact that two other companies in addi-


Printed circuit board held by RCA engineer in laboratory contains four micromodules (circled in upper end of board).

tion to RCA recently established facilities to produce modules — P.R. Mallory & Co., Inc. and Paktron Division of Illinois Tool Works, Inc. — and 61 other firms are participating in the program by supplying a wide range of microelements.

Because micromodular equipment already built for the Army has surpassed the goals for size, weight reduction, ease of maintenance and reliability, the Army has awarded contracts during 1962 for new micromodule applications, General Cook pointed out. Among them are:

• Procurement from RCA of an initial lot of 350 micromodularized back-borne walkie-talkie radio sets. The Army uses walkie-talkies by the tens of thousands.

• Procurement from Mallory of an initial 400 micromodular intermediate-frequency amplifiers of extremely high reliability. The conventional package now requires as many as a thousand replacements monthly.

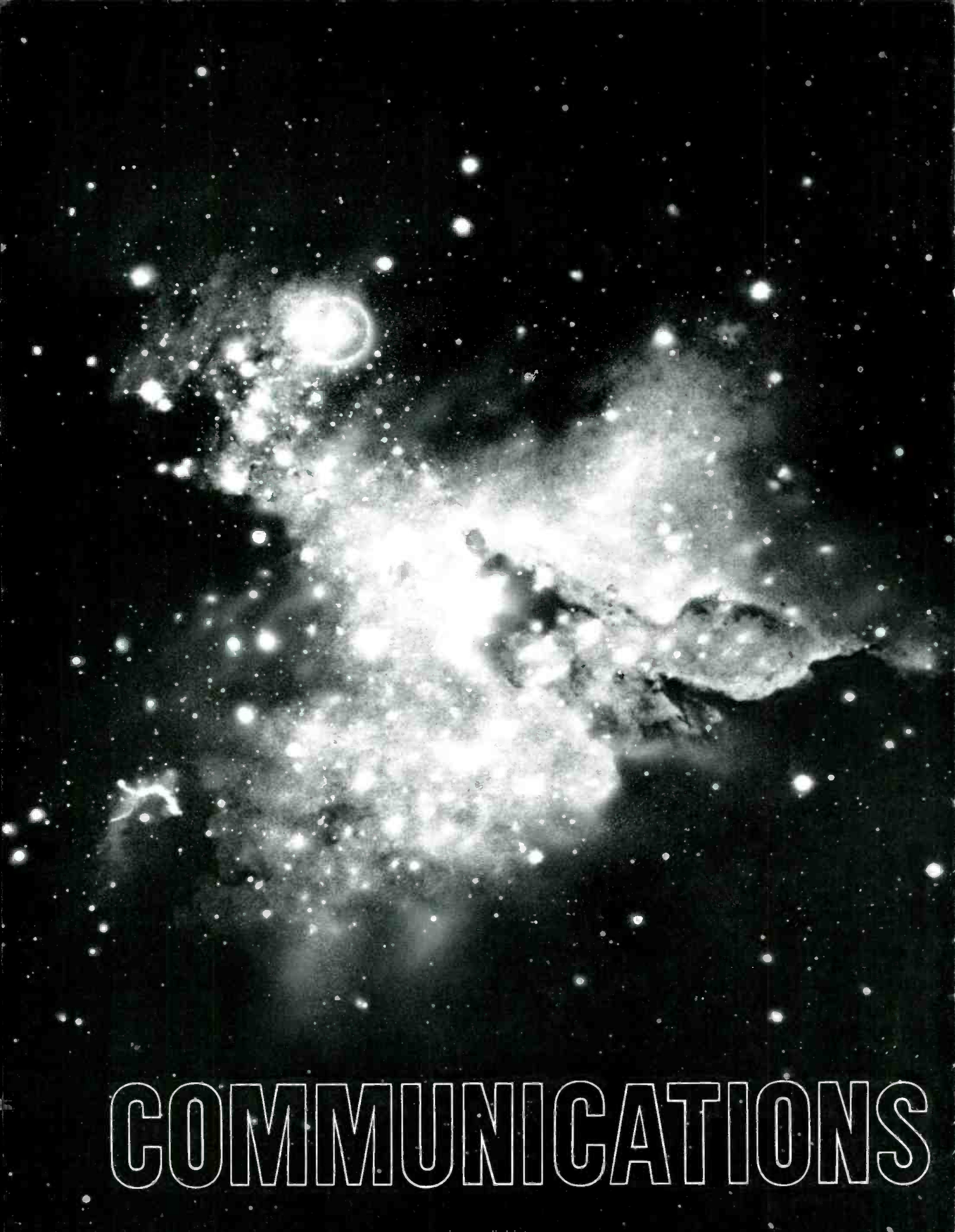
• Procurement from RCA of a mobile computer for filed data use, employing some 10,000 micromodules and to be delivered in about 14 months. Future plans provide for development of an entire family of varying sizes of such systems.

Meantime, six other items considered highly suitable for micromodule application have been chosen for research and development in Fiscal 1963-64. They are:

1. An airborne high-frequency single-sideband radio.
2. A lightweight hand-held surveillance radar.
3. A "flash ranging set" to direct gun flashes.
4. An electronic teletypewriter.
5. Tactical digital communications systems.
6. A production version of a small field computer known as Micropac, the prototype of which will be delivered this November by RCA.

"The savings that can be realized through reduced weight and size are fairly obvious," General Cook said. "Greater reliability promises fewer breakdowns. When they do occur, repairs will be easier to make because the man in the field will find it easier to locate and replace one faulty module out of say, ten, than it is to find a faulty part among 200, as we must do today." This, the General pointed out, would reduce intensive and prolonged training of highly skilled repairmen.

Recalling predictions at the outset that "micromodules can have great significance for future Army operations," General Cook said: "Today we can speak with assurance. The Micromodule Program is a success . . . Micromodules are having a highly significant impact on Army electronics and the effects will become much greater as we continue to implement our plans." Indeed, the micromodule is "on the march." ■


COMMUNICATIONS

by RCA Chairman David Sarnoff

A challenging by-product of technical progress in the 1960's is the demand for new and creative approaches to legislation for a society in transition under the influence of onrushing science and technology.

A case in point is the present development of communications satellites to span the world with high-capacity television, microwave radio, and data transmission. The new satellite techniques will profoundly alter past patterns of international communications and the administrative and regulatory structures within which the various services are provided today. An initial step in adapting to the new era already has been taken by Congress with the passage of legislation to establish a Communications Satellite Corporation.

A further long step, looking to the needs of the long-range future, was proposed on August 7 by David Sarnoff in an address to the American Bar Association in San Francisco. He called for a single U. S. international communications company uniting the facilities and operations of all present competing American carriers engaged in international service in order to bring "coherence and viability" to the nation's communications services in the Space Age. Here are highlights of this significant address.

Last July 10, an event of vast importance in world communications occurred with the successful orbiting of the AT&T's "Telstar" satellite. Already, the next important step in the development of global space communications is in progress. A second communications satellite — the "Relay" — designed and constructed by RCA for the National Aeronautics and Space Administration, will be launched later this year for further experiments. These will include telephony, telegraphy and other forms of recorded communications as well as intercontinental television. There also will be tests of the effects of radiation on equipment while the satellite is in orbit.

Communication satellites are forerunners of a system that within the coming decade will provide virtually instantaneous telegraph, telephone, data, television and other forms of communications to practically any point on earth. They open a dramatic vista of unlimited range for linking the world in a common dialogue, with incalculable effects on the thinking, the understanding, the culture of all mankind.

The advent of the communications satellite could hardly be better timed. By 1965, it is estimated that present international communications facilities will reach saturation in many areas. To handle the increased traffic, on key routes such as the North Atlantic, we would need, within a decade, the equivalent of fifty new cables costing several billion dollars. But, a single satellite can equal the carrying capacity of all the telephone circuits presently in operation between the United States and the rest of the world.

In its advanced form, I believe our space communications system will consist of three synchronous satellites, each positioned about 22,300 miles above the equator. Moving at a speed matching that of the earth's rotation, they will in effect hover over a fixed point on its surface. Three such satellites, one each over the Atlantic, Pacific and Indian Oceans, would cover the entire global land area, except the polar regions. One of these satellites above the Atlantic could interconnect with services that presently include over 90 per cent of all the telephones in use in the world. It could also transmit to television stations over an area extending from the eastern United States across Western Europe and including all of Africa and South America.

From these facts we can begin to postulate the communicating world of tomorrow. It will be a world in which an individual, business or government can establish contact with anyone, anywhere, at any time.

Global conferences, whether of statesmen, businessmen or lawyers, will take place with each participant sitting in his own office or home, in full view and hearing of the others; exchanging thoughts, documents and data through desk instruments and a color TV screen on the wall.

Storage of information, its retrieval and transmission, will be directed from centralized computer facilities and widely distributed memory systems. It is possible to foresee practically instantaneous up-to-the-minute status reports on any major national or international problem — legal, medical, economic, political or other — flashing from continent to continent.

No man can foresee the precise impact of global television — for entertainment, information and education — upon the peoples of our globe. In time, it is probable that high-power satellites will transmit tele-

AND THE LAW

vision directly to the home, and it has been suggested that within a lifetime this may lead to a universal language which all educated people will understand.

Whether we scale these summits of promise is more than a matter for science alone. The manner in which we organize and administer the far-flung communications services will shape their future as surely as the instruments we loft into space.

Our communications policies, as they now stand, offer striking examples of the difficulties in designing the future based on blueprints of the past. These random policies governing today's operations have evolved principally from the separate historic development of the land-line telegraph, ocean-cables, wireless telegraphy, the radio telephone and national and international broadcasting. Some of these policies began in the middle of the last century. All of them are regulated by laws based more on tradition than on the needs of an expanding society in a changing world of science and technology.

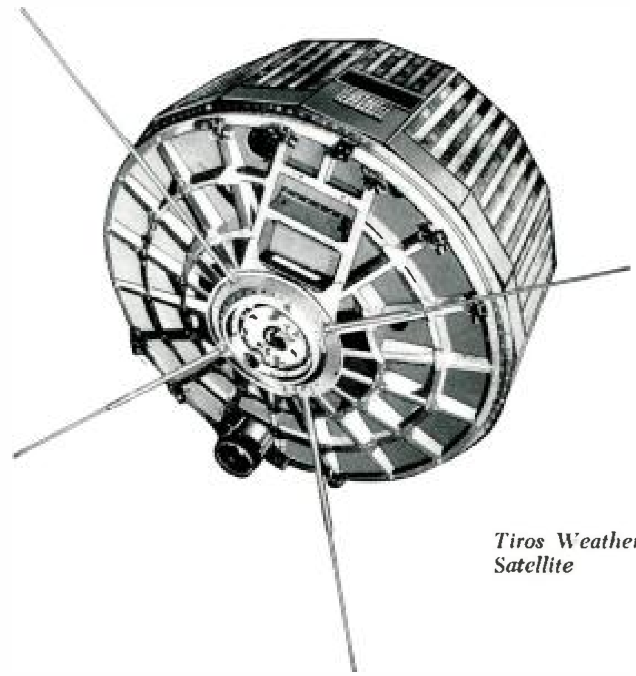
Thus monopoly was made lawful in some areas of communications and unlawful in others. International communications were held distinct from domestic. In the international field, monopoly and competition were created side-by-side. Meanwhile, the march of science has erased the line that separated telephony from telegraphy, has created new forms of record communications, such as teletypewriter, and facsimile.

The recently approved Communications Satellite Corporation establishes a form of legal monopoly, but the communications companies authorized to participate in its ownership — most of them at least — will still be in competition with each other, and perhaps in competition as well with the satellite corporation of which they are part.

The public telephone service within the United States is a monopoly sanctioned by law. So is the public telegraph service. When telephony extends overseas, it is also a monopoly; but not so with international telegraphy. Here, ten American companies, operating in the international telegraph field, must compete for traffic which at the foreign end is usually handled through government monopoly. Rates and services are subject, in each case, to mutual agreements which must be negotiated by American private competitors with the foreign government monopolies. These organizations can — and some on occasion do — play one company against the other with resultant disadvantage to American companies and the American public.

Today, technical developments in communications have completely blurred the earlier distinctions between voice and record messages. Both can now be sent and received over the same circuit. And the circuits can connect directly any points in our country with any other part of the world. The individual or organization wishing to talk, transmit and record information at the same time, is no longer satisfied with partial service or the inconvenience of separate services. Yet, where an American international telegraph company is able and willing to provide a full public service, it cannot utilize the existing international voice circuits for such a purpose, nor can it interconnect with the established telephone service in our country.

The prospective Communications Satellite Corporation presumably will be able to grant authorized communications companies the right to transmit both voice and record messages through the satellite. But the satellite is only one link in a communications chain between the sender and the receiver. If an American carrier of international traffic has the right to send both voice and record over the satellite but is not allowed to interconnect freely with the corresponding domestic services, its effective use of the satellite is denied. And, even if it can interconnect with domestic facilities via the satellite, but is forbidden to do so over its standard cable or radio services which will continue to be used, it will still suffer an unwarranted handicap.

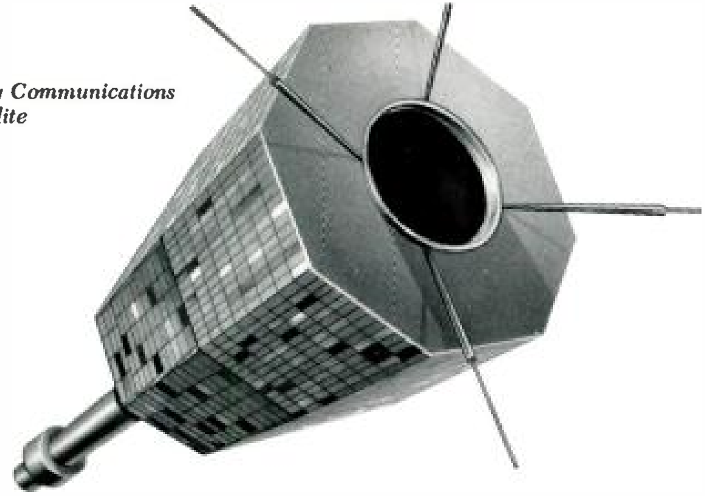


Tiros Weather Satellite

It is a matter of prime national concern that in this country, which has pioneered in communications and through our private enterprise system has produced the best telephone, telegraph and broadcasting services in the world, present legal limitations prevent the fullest development of a truly universal service — a service that could give the American public all the benefits offered by modern science.

I would consider the following questions as among

Relay Communications Satellite



those urgently in need of study and resolution if we are to secure all the public benefits modern science and technology promise us:

1. Will our Nation's interests in the Space Age be served well and adequately by preserving the present pattern among communications services, with all the illogical limitations and unnecessary handicaps under which American companies now must operate? Or, should we create by law a new pattern cut to the public interest and the capabilities of modern science?
2. What measures should be taken to assure the most efficient and economical use of frequencies and facilities employed in domestic and international communications — whether by satellites or other means?
3. What principles of international agreement should govern participation by foreign nations in the ownership and use of an American global satellite communications system? Conversely, on what reciprocal basis would we be permitted to participate in such satellite systems as may be established by foreign countries?
4. What authorities should be established for adjudicating possible differences and conflicts among international participants and users of the new space communications system?
5. What agreements should be sought to guarantee freedom of the content of satellite radio and television broadcast transmissions, particularly in view of the differing cultures, ideologies and conflicting philosophies of operation now prevalent?
6. What means should be used for assisting less developed countries to establish ground facilities linking them with communications satellites, particularly where extension of the service will not be economical from a commercial standpoint?

Of these six questions requiring resolution, I place the highest priority on the first.

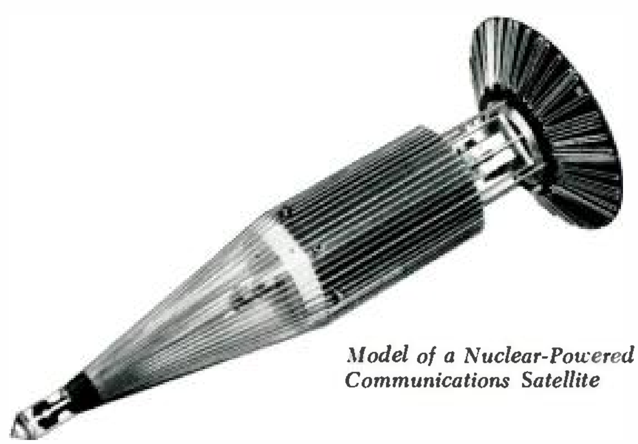
Based on long experience in this field, my own belief is that the most practical solution would prove to be the creation of a single, privately-owned American company, uniting the facilities and operations of the present competing U. S. carriers, *in the international communications field.* This company should be completely independent in its policies and operations, subject only to appropriate Government regulations.

Such a unified company would be able to render a complete service to the public with all the advantages made possible by modern science and technology. And surely there is every logical reason for such a company to give further cohesion to our entire communications structure by interconnecting the flow of its international traffic with established domestic facilities.

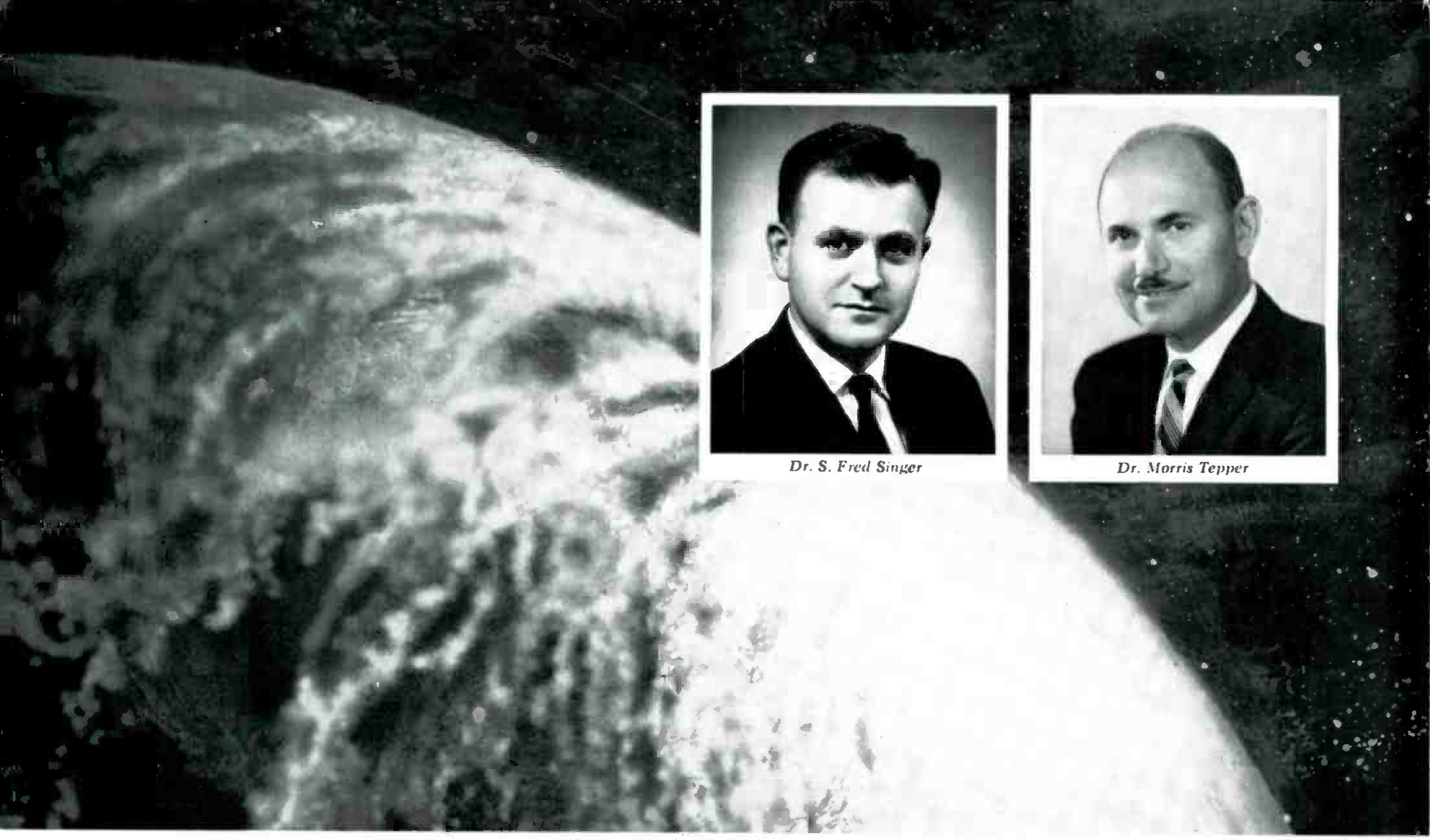
Through these steps, our international communications services would become more flexible, more convenient and more economical to the public — at home and abroad. And our unified American company would be able, for the first time, to deal on equal terms with foreign government monopolies.

If we are to preserve and secure the benefits of the American concept — the privately owned and operated systems of national and international communications, functioning under appropriate Government regulations — and if we are to avoid the alternative of Government ownership of these vital public services, then we must develop and adopt, before our opportunities are diminished by time, a *Unified National Communications Policy* that would resolve the questions I have raised and be suitable to our current and future needs. Such a national communications policy should be sanctioned by the Law.

The legal architect and the communications architect can further these ultimate and mediate ends by combining their talents in a searching examination for the answers to the communications problems we face. Their findings and recommendations should prove invaluable to those Government departments and agencies concerned with such problems. Out of such a joint effort could emerge a legislative program that commended itself to the President and the Congress. ■



Model of a Nuclear-Powered Communications Satellite



Dr. S. Fred Singer

Dr. Morris Tepper

SPACE STATIONS FOR THE

by Dr. S. Fred Singer, *Director, National Weather Satellite Center, United States Weather Bureau*

THE NATIONAL WEATHER SATELLITE CENTER is the result of an historic act of Congress taken in September 1961 which called on the Department of Commerce Weather Bureau to establish and manage a National Operational Meteorological Satellite System (NOMSS). The act was historic in that it established the first operational satellite system.

As managers of NOMSS, the National Weather Satellite Center is charged with a statutory responsibility "to establish and operate a system for the continuous observation of worldwide meteorological conditions from space satellites and for the reporting and processing of the data obtained for use in weather forecasting."

The weather satellite program today is based on the highly successful TIROS series which began April 1, 1960. Though originally launched as a research and development satellite, TIROS was so immediately successful the Weather Bureau was able to begin using the data on an operational basis. To date, the Meteorological Satellite Laboratory, the research section of the NWSC, has published more than seventy papers and reports dealing with results of investigations using both picture and radiation data.

Cloud pictures supplied by TIROS are the basis for the operational use of the satellite. The pictures are used to prepare nephanalyses, cloud maps, which are furnished to the National Meteorological Center, and to field stations both in the United States and overseas for use in daily operations. The mechanics of processing the data and preparing the nephanalyses has improved steadily so that the average time between acquisition of pictures from the satellite and transmission of the nephanalysis worldwide, either in coded or facsimile form, is about two and a half hours.

The most significant initial benefit resulting from the weather satellite has been its ability to discover and track major storms. In the summer of 1961, TIROS III discovered Hurricane Esther and tracked it and seventeen other hurricanes, typhoons and tropical

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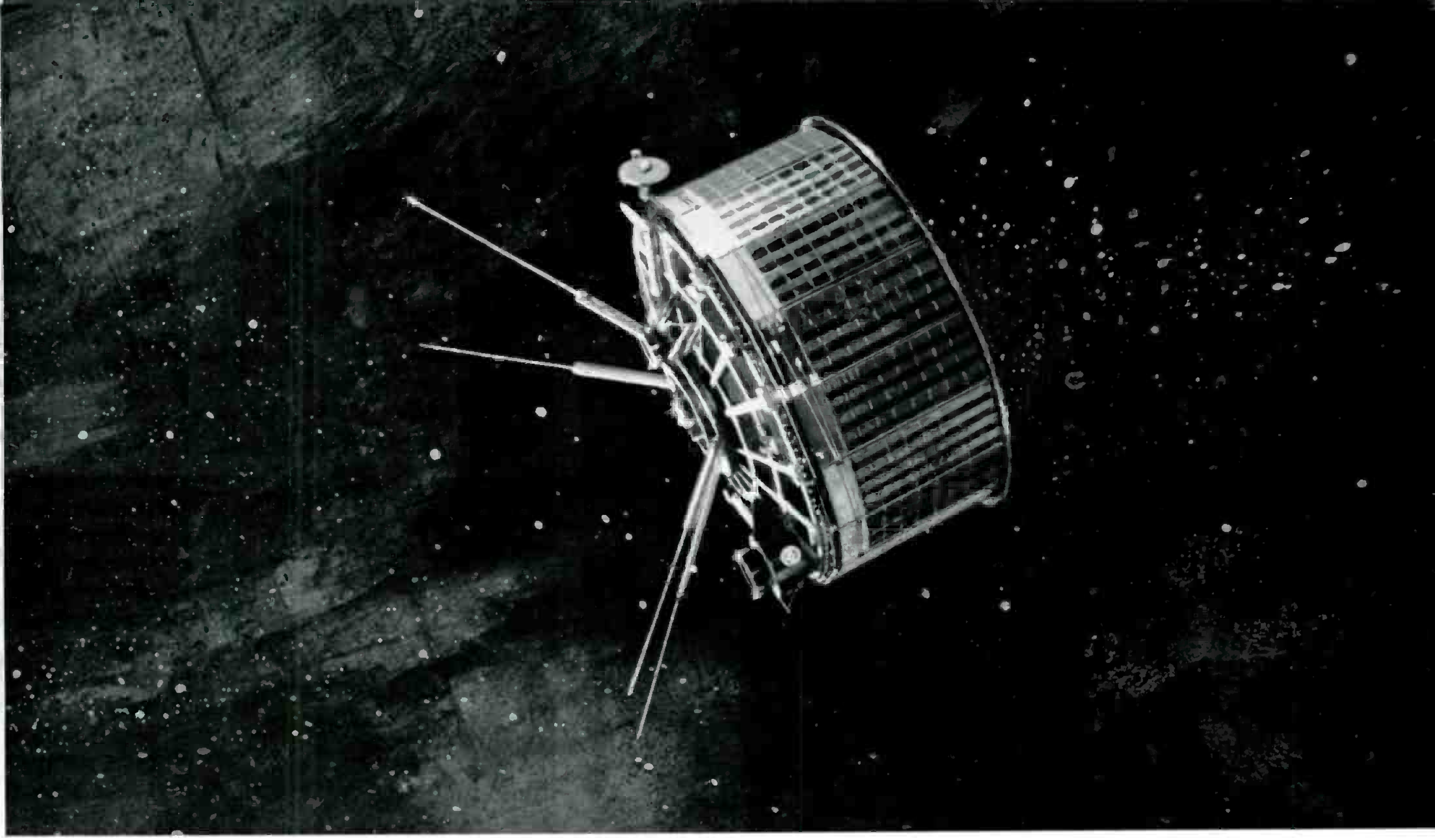


WEATHERMAN

Men guiding Government's meteorological satellite program report on new dimensions of weather forecasting with TIROS and future services to cover the globe

by Dr. Morris Tepper, *Director, Meteorological Systems, National Aeronautics and Space Administration*

THE HIGH COSTS and substantial manpower efforts that are involved in space programs dictate that any decision to utilize space technology in a continued, routine daily application must be made only after careful study of the anticipated benefits. In the case of meteorological satellites such an expenditure of resources is well warranted. Weather satellites appear to hold immediate promise in terms of savings in human lives and property and more generally, in the savings resulting from an improved forecasting service. Weather satellites do this by providing the data necessary for more accurate identification, tracking, and forecasting of atmospheric weather events and, in particular, hurricanes and other severe storms.

The National Aeronautics and Space Administration is developing meteorological satellite systems for worldwide observation of the atmosphere for both operational and research purposes.

From 1958 when NASA was created, and the subsequent transfer of the TIROS project to NASA early in 1959 when the agency was yet less than a year old, meteorological satellites have received prominent attention in the agency flight program. Almost immediately upon receiving cognizance of the TIROS project, NASA organized an interagency group, the Joint Meteorological Satellite Advisory Committee (JMSAC), to insure that the requirements of all weather data users were adequately considered and met in the program. In April 1960, TIROS I was put into orbit and its operation both as an engineering development and data-producing observational tool was successful beyond all expectations. The continuing importance attached to this aspect of space technology is reflected in the care and effort which yielded TIROS V on time early this summer. This satellite made it "five-out-of-five" for the TIROS project.

NASA recognized from the outset that TIROS was a relatively simplified satellite system and only an immediate-necessity item, and that the ultimate system would have to be much more complex. The complexity

Continued on page 14, column 2

Dr. S. Fred Singer (*continued from page 12*)

storms in the Atlantic and Pacific Oceans. During August 1962, TIROS V discovered one hurricane and four typhoons – thus, fulfilling its programmed mission as a "hurricane hunter."

In other areas where weather information plays a vital role, the TIROS has proved itself to be a valuable tool in forecasting and prediction. Recently an airline pilot on a flight from New York to Africa stated that the TIROS cloud cover map provided him by the Weather Bureau was "so accurate as to be unbelievable."

The Weather Bureau continues to provide weather support based on the satellite data to all branches of the military services and to the National Aeronautics and Space Administration in connection with their various launchings, including manned space flights.

Research using the satellite pictures has included studies of the formative stages of hurricanes, atmospheric motions, tropical circulations and weather, the distributions and characteristics of ice and snow, jet streams and associated turbulence, convection phenomena and applications to numerical weather prediction models.

Radiation data from the satellites have been used as a basis for studies of the planetary radiation balance and the correlation of the radiation measurements with cloud cover, the height of cloud tops and with land and ocean surface temperatures.

Because of the immense value of the TIROS satellites, the NWSC has recently proposed that it be made operational until such time as the more sophisticated Nimbus becomes available. The proposal calls for two TIROS satellites to be in orbit at all times with a third on stand-by for launching. One would be the NASA R&D TIROS and the second would be an NWSC funded operational satellite.

The Nimbus satellite now under development is expected to be the first satellite which will meet the needs of an operational weather satellite system. Nimbus will overcome the two basic limitations of TIROS in that it will view the polar regions and will provide continuous observation of the earth's cloud cover.

The wealth of new information resulting from Nimbus will give scientists an abundance of material for advanced research into causes of atmospheric motions and planetary circulation. The cloud climatology of the earth, particularly over its oceans and polar regions may be completely revised as the data are accumulated and analyzed.

Weather satellites have many non-meteorological applications, some of which have been explored and put to use.

Soon after the launch of TIROS I, it became obvious that ice could be detected and studies were immediately begun to utilize this information. Findings from these studies are expected to be of great importance to merchant shipping and polar operations.

Similarly, snow surveys are being conducted which may be beneficial in areas of hydrological importance.

Future weather satellites may carry experiments which will detect forest fires which cause an annual loss in the United States ranging from $50 to $300 million and have taken 127 lives in the five year period ending in 1961. The greatest loss has been from those fires not detected early enough. The satellite may be the answer.

Space technology has given us a tool in the weather satellite which is yielding many practical benefits – benefits that are shared with all mankind. We can expect the future holds benefits not yet imagined. ■

On September 18, 1962, the National Aeronautics and Space Administration launched the TIROS VI successfully into orbit from Cape Canaveral – the sixth successful launching in six attempts in the nation's weather observation satellite program.

TIROS VI was designed and built, as were its five predecessors, by RCA's Astro-Electronics Division for NASA's Goddard Space Flight Center. It was speeded into orbit while TIROS V was still in operation, to augment the televised weather data from space in time for the planned orbital flight of Astronaut Walter M. Schirra, Jr., and for the traditional fall season of severe tropical storms.

The record-breaking reliability of the TIROS series has made this perhaps the most successful space program undertaken by the United States. In a story on the TIROS VI launching, the New York Times stated on September 19:

"Within the space agency, the success of the TIROS project, exceeding that of any other civilian space project, is attributed to an attention to details and a concern with reliability on the part of two groups. These are the Goddard Space Flight Center, which has responsibility for managing the project, and the RCA Astro-Electronics Division in Princeton, N. J., which builds the satellites.

Dr. Morris Tepper (*continued from page 13*)

is dictated by the wide scope of basic observations desired by the meteorologist in an operational system. Requirements to be satisfied even in an initial operational program include:

1. Daily global cloud cover observations

2. Twice daily global mean temperature of radiating surfaces

The kinds of data required for future operational programs include in addition:

3. Daily cloud cover in pictorial form at a minimum daily frequency of once during darkness
4. Winds throughout the environment where operations are expected
5. Heights of cloud bases and tops
6. Extent of area and approximate intensity of precipitation
7. Vertical temperature, moisture, and density structure of the atmosphere
8. Index of refraction
9. Height of tropopause and ionospheric layers
10. Surface pressure
11. Ground cover (e.g., snow, ice, vegetation, etc.)

With the TIROS design we are able to satisfy only, to a very limited degree, the first two requirements. From an operational point of view, that is, providing data in "real time" for the *immediate* use of the forecaster.

The TIROS system yields only cloud cover picture data and for approximately ¼ of its orbit as it passes between about 60°N and 60°S. The required temperature data are not available in real time at all since the infrared radiation data must be processed and evaluated before they can be interpreted as temperatures. In order to design for a more complete operational system, several features are required which are not contained in the TIROS configuration. The satellite must have earth stabilization in order to be able to view the earth continuously. It must be launched into a polar orbit in order to view the entire globe. Our development program to date has been concentrating on TV camera systems and certain IR radiation measurement systems. More generally, however, our basic R&D program provides for exploring the possible use of other sensors and devices for measuring some of the other quantities listed above. The satellite design must allow for growth in order to permit the inclusion of these other sensors as they become developed without necessitating a costly spacecraft redesign each time.

That is essentially the configuration of the Nimbus satellite that is now being developed. It will be earth stabilized; it will be launched into a polar orbit; it is designed on a modular concept to accept new and improved sensors. Nimbus is yet to be flown and at present must be considered to be an R&D spacecraft. However in the meantime, NASA continues to be responsive to the operational requirements that are to be met. Consequently, provision is being made, even in this R&D system for the operational utilization of the output. It is planned to have some temperature data available in real time in the Nimbus program.

Our plans are that we will probably need four Nimbus R&D satellites before we have a reliable satellite, capable of providing to the weather data user the minimum data that he requires. The first two research and development satellites will be, essentially, minimum satellites, launched for test purposes, to test out the basic system and the basic configurations.

The third Nimbus satellite will include sensor redundancy in an elementary form, by having duplicate systems, and finally, the fourth research and development satellite will be an integrated redundant system, where individual parts of subsystems can be interchanged in order to provide a system with longer life.

Problems, we feel, will last through about 1965. After this period, if everything has gone as planned, we shall have a reliable satellite, one that can be regularly scheduled and routinely launched, one that will completely satisfy the first two requirements listed above. This satellite will form the basis for the Weather Bureau managed National Operational Meteorological Satellite System (NOMSS).

The NASA meteorological satellite program planning has been proceeding in the direction of the development of two basic satellite systems. The first, the Nimbus satellite which we have just discussed, is a set of satellites in near polar orbits at altitudes of five to eight hundred miles. These will provide relatively close-up looks at all points on the earth, including the polar regions, in a recurring manner. The second is an arrangement of satellites in a synchronous, stationary orbit above the equator at an altitude of about 22,300 miles. These will allow continuous viewing of very large areas, the entire disc of the earth as seen by each satellite, but with poor coverage of the polar regions. It will also have a capability for viewing in finer detail selected smaller regions. The stationary equatorial orbit system is now in the early study phase.

Concurrent with its participation in the operational meteorological satellite system, NASA will conduct continuing research and development in advanced satellites, satellite systems and sensors both polar and equatorial orbiting. The Advanced R&D satellites considered in this plan are primarily follow-on spacecraft of improved capabilities and sensors. Improvements being considered include electrostatic tape cameras, image orthicon camera systems, improved IR and microwave sensors, control and stabilization systems, power sources, etc.

NASA, as the civilian space agency, has been given the responsibility for developing satellite systems for meteorological applications. This we are doing in cooperation with the Weather Bureau. ■

Song-and-dance shenanigans spark award-winning Shari Lewis show.

TV's Mr. Magoo in "The Christmas Ca

CHILDREN'S PROGRAMMING:

NBC's 1962-63 season

features a host of children's programs

blending education and entertainment

Dr. Albert Hibbs (center), puppeteers and "friend" host NBC's "Exploring" show—keynote of programs.

ol."

Cello "discourses" on music arts on "Exploring."

NEW CONCEPT IN TELEVISION

Simple devices demonstrate complex scientific principles on the "Watch Mr. Wizard Show."

NBC'S launching of an unprecedented number of shows for the 1962-63 season designed for the affirmative development of its youthful viewers will give television's cowboys and Indians more competition than they ever got from the U.S. Cavalry. With the trend to more and more educational programming, the National Broadcasting Company has skillfully blended both educational and entertainment values into the new programs.

In fact, the children's programming situation looks so good from the network's viewpoint that Mort Werner, Vice President, Programs, predicts NBC "will have on view the most intelligent balance of entertaining and educationally attractive programs for children ever seen on NBC-TV or any other network."

Balance is the key to the new NBC line-up in children's fare just as it is for adults – and it's all been achieved as a result of several years of careful research into youthful needs and interests.

NBC is especially proud of its new full-hour educational series for youngsters titled "Exploring," which premiered on the network Saturday, Oct. 13 at 12:30 p.m. EDT. It was conceived in the Fall of 1961 as the keystone of NBC-TV's children's programming, and now, after a year of planning, it is a reality.

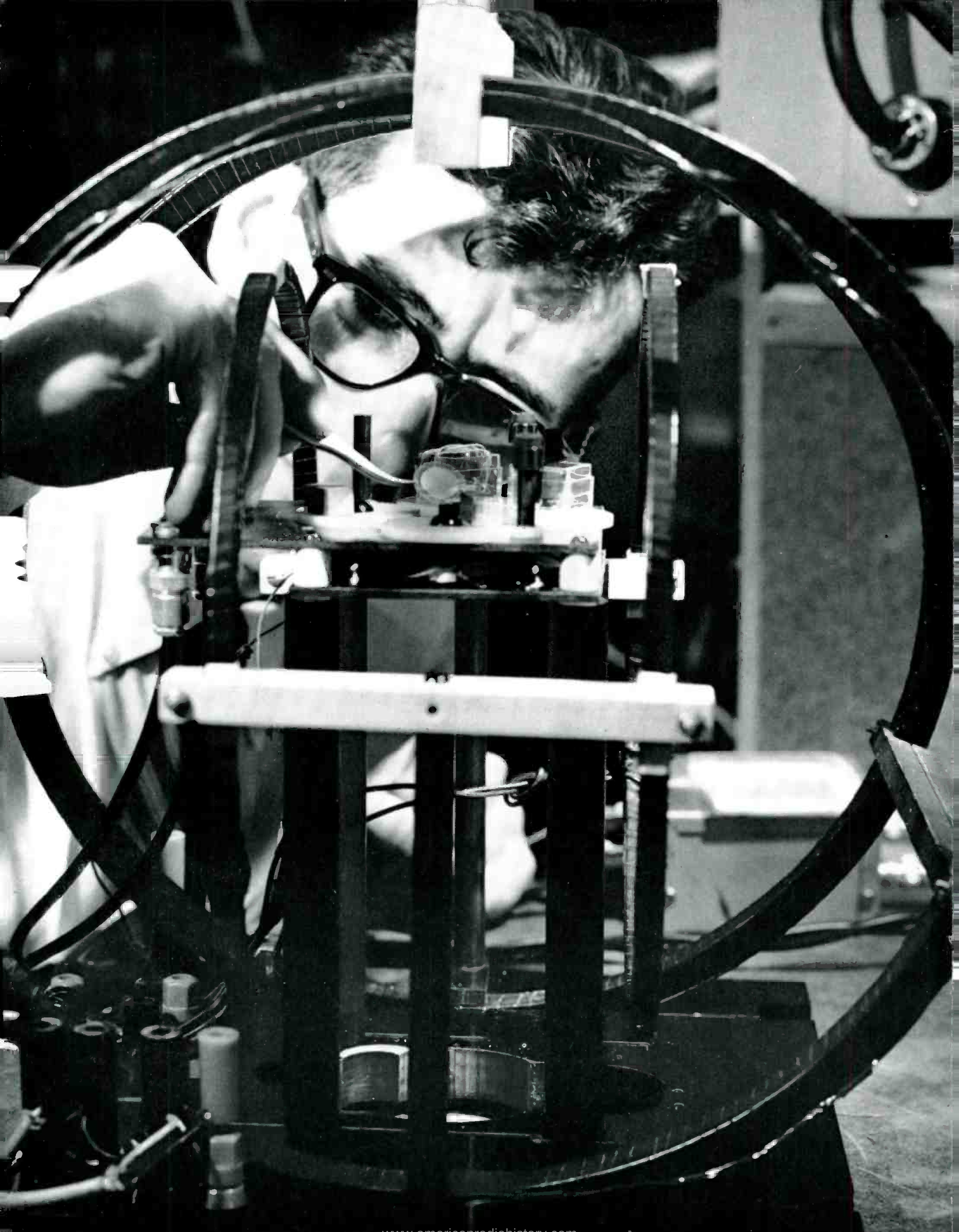
"Exploring" is a high-caliber hour aimed at youngsters 5 to 11 years old and designed to stimulate their interest in five major avenues of learning – language, music, mathematics, social studies and science.

It is hosted by Dr. Albert R. Hibbs, nationally known scientist at the California Institute of Technology Jet Propulsion Laboratory, plus an assortment of puppeteers, musicians, cartoon strips, films, guest experts, and visual aids.

Other children's shows (called by Robert F. Aaron, Director, Daytime Programs for NBC-TV, "the best balanced children's schedule in NBC's history") scheduled for the "Saturday morning strip" – traditionally reserved for children's fare – include "Ruff and Reddy, starring Captain Bob,"; "The Shari Lewis Show," "King Leonardo," "Marx Magic Midway," a circus variety show; "Make Room for Daddy," family comedy; and "Mr. Wizard," the nation's longest-running science TV show.

NBC specials appealing to children are imposing. They include a one-hour documentary on the meaning and evils of communism and a novel one-hour entry on the entertainment side: "Mr. Magoo's Christmas Carol" – a serious adaptation of the Charles Dickens classic featuring the familiar cartoon figure of "Mr. Magoo."

NBC is proving that shows with a *"Let's Comprehend"* theme can be as much fun as the sometimes cloying, vintage "Let's pretend" programs.



The Ultimate in Mnemonics

Newly-developed electronic memories "remember" data for government, industry and space programs. In fact, they will remember anything they're told to . . . .

by Bruce Shore

ASKED TO DESCRIBE A MODERN LIBRARY, you would probably say it is a building consisting of a librarian, a place to store books and a card index using numbers and letters to specify each book's location.

Ask the same question of an electronic memory engineer, however, and he might well rattle off that it is a book-organized, random-access, title-addressable memory system employing an alpha-numeric code and a human sense-winding.

Baffling as the second definition may sound, it says precisely the same thing as the first but does so in an extraordinary jargon that has grown up around one of the electronic industry's most astonishing achievements – *the electronic memory.*

Conceived in the early 1940's, electronic memories have been a major focus of RCA research and development ever since. In the intervening years such pioneering achievements as the *Selectron* and the *Myriabit Memory,* both developed by Dr. Jan A. Rajchman of RCA Laboratories, have contributed importantly to their present form and performance.

Like a library, they consist of three essential parts – an area to store information, a means for putting it in or taking it out, and an indexing system for locating each separate item. This last or indexing system differs from that of a library only in using a binary instead of a number-and-letter code. Thus, all information put into them is first converted to a language whose alphabet consists of two letters only – negative and positive voltages – and whose words are arbitrary combinations of those "letters".

To appreciate how much information such an indexing system can handle, consider one of the world's best known binary systems – Morse Code. With an alphabet of only two letters – dot and dash – enough combinations can be made (26) to transmit every thought and word in the English language. The same holds true for the binary system of electronic memories.

For binary storage, electronic memories contain a multitude of independent elements or memory cells which are capable of storing plus or minus voltages or their magnetic equivalent. (Since electric currents always come with associated magnetic fields, it is possible to use either the electric or magnetic component for storage.)

"Writing" binary information into the memory is made possible by stationing each cell at, near or around the intersection of a horizontal and a vertical wire or other electrical conductor. Since many cells are involved, the many wires needed are laid out in the form of a grid with a cell at each intersection in the grid. The resulting assembly is called a "memory plane". In today's standard computer, several planes are usually wired together to form a "memory stack".

"Writing" itself is accomplished by picking one horizontal and one vertical wire and sending a unit of electric current down each. In this way, any one – and only one – of the memory cells can be made to intercept both units. Since interception of both is the sole condition on which a cell will store a plus or minus charge (or magnetic field), any cell or sequence of cells can be set as desired.

To "read" them out, the same vertical and horizontal lines are used, but this time the two units of current are of opposite sign to those that did the "writing". When they converge on the selected cell, therefore, they switch its charge or magnetic field to the opposite sign too. As this happens, electromagnetic forces caused by the switching induce a voltage in a nearby wire, termed the "sense-winding", which carries it outside the memory. With cells in other planes of the memory stack undergoing a similar process simultaneously, the output of the memory as a whole

Dr. Harry L. Pinch, RCA Laboratories, centers thin-film permalloy memory element for computers in magnetic field measuring device.

is a series of positive and negative voltages which eventually reach such peripheral equipment as an electronic typewriter. Here, they are converted instantly, in accord with the binary code being used, to everyday English.

Though some experiments using arrays of electrical relays in "on" and "off" positions to store binary information were conducted in the early 1930's, the real history of electronic memories — and computers — begins in 1939 with a little known visit paid to RCA by representatives from the Frankford Arsenal in Philadelphia, Pa.

RCA Computer Research Laboratory Director, Dr. Jan A. Rajchman, compares early and recent computer memories.

Disturbed by the outbreak in Europe of what later became World War II, and alarmed at the speed and maneuverability of the German Luftwaffe as shown in its blitzkrieg of Poland, these representatives wanted RCA to develop an electronic fire-control system for anti-aircraft guns to replace the slow and cumbersome mechanical "directors" then in use.

After considerable study of the question including an exhaustive canvass of the technical literature, Dr. Rajchman and his associates agreed to undertake the assignment. Subsequently, their work took two separate directions.

The first derived from the fact that a mathematical relationship exists between the vertical and horizontal angles of a gun and the flight-time of its shell insofar as hitting a target is concerned. Since this relationship is fixed and can be written down as a mathematical table, Dr. Rajchman set out to build an electrical analogy of such a table. The outcome was "the resistive matrix arbitrary function generator," a plate with horizontal conductive lines on one side, vertical lines on the other and holes containing tiny electrical resistors wherever these lines crossed. Despite its name, this novel device was what we would now call a "read-only" memory — the first ever built.

The second direction led to the development of electronic devices that could perform arithmetic. For the resistive matrix to do its job, something had to tell it how high the aircraft was, how fast it was flying and how soon the anti-aircraft shell would explode after firing. This could only be done by rapid calculations made from data provided by the gun crew. For these calculations a whole new family of electronic counters, multipliers, shift-registers and the like was evolved.

As the number and variety of these increased, however, so did the number of vacuum tubes they used. Fearing a trend toward overcomplexity, Dr. Rajchman conceived the idea of a single, integrated tube that could add, subtract, multiply and divide electronically. Later, he actually designed such a tube — dubbed the *Computron* — and recommended its joint use with the resistive matrix to produce the fire-control system desired.

This idea was especially intriguing to the U.S. Army which was then fully engaged in World War II and having serious difficulty providing ballistic tables for its field artillery in advance of actual use. *Computron* needed extensive development, however, and RCA, already heavily engaged in the U.S. war effort and convinced that the proposed fire-control system would prove far too complicated to achieve in time, turned the suggestion down.

It was then made to the University of Pennsylvania whose Moore School of Engineering was also involved in research on machine computation. The University accepted and, during the next few years, under the guidance of Dr. J. Presper Eckert and Dr. John Mauchly with Dr. Rajchman as an early consultant, proceeded to build *Eniac,* the world's first electronic digital computer. The year was 1946.

Eniac used a resistive matrix for memory and also incorporated another form of memory device — an electrical "patch-board" for telling the computer how to process the information it stored. Something like a telephone switchboard, it could be used by an operator to wire in an electrical model of the problem to be solved plus instructions on how to solve it. Analogue computers still employ such patch-boards for programming even today.

The next big advance in memories, also recorded at the Moore School of Engineering, came in a computer named *Edvac*. For information storage, *Edvac* used a mercury delay line – a narrow pool of mercury with piezoelectric crystals at either end. Such crystals have an ability to convert sound waves to electricity or *vice versa*. When an electrical current bearing binary information was sent into one of those crystals, it was converted to an acoustic wave which propagated through the mercury, only to be converted back to electrical pulses by the crystal at the other end and returned to begin the cycle all over again. Thus, an electro-acoustical train of binary pulses was trapped in the circuit and could serve as a memory.

Here matters rested temporarily, while scientists and engineers pondered what next step to take. The answer came soon enough in a far-reaching proposal put forward by Dr. John Von Neumann of the Institute For Advanced Study in Princeton, N.J.

A world-renowned physicist and mathematician, Dr. Von Neumann had been following computer developments with keen interest. He felt their potential was something beyond mere weapons control and in the light of what had already been accomplished, he formulated the revolutionary concept of a universal computer – one that could solve any problem. Crucial to this concept, clearly, would be a memory capable of storing both the data to be processed and the instructions on how to process it. In addition, it seemed such a memory would have to be completely electronic and would have to provide random access to any of its storage elements for both "writing" and "reading". It was not, however, until Dr. Rajchman's demonstration of the *Selectron* in 1948 that a practical, fully digital device for doing this was available.

A vacuum tube containing 256 memory cells pierced by tiny holes and arranged in the form of a grid, the *Selectron* could produce 256 different electron beams with which to bombard, selectivity, any one of these cells. Depending on how the cells were controlled during such bombardment, they could acquire and retain a negative or positive charge.

To "read" any one of them out, the appropriate electron beam was again used. If the cell was negative, the beam, composed of negative electrons, was repelled. If it was positive, the beam was attracted right through the tiny hole in its center and detected by an electronic device behind it. Therefore, it was possible to determine which cells were negative and which positive and, thereby, to learn what binary information each contained. Such was the first random-access digital memory.

The *Selectron* might well have gone on to become the heart of the modern digital computer had research on it continued, but it was abandoned in the early 1950's following development of the magnetic core.

It had been known for many years that certain metal alloys, such as permalloy, displayed an ability to maintain a magnetic field flowing in a clockwise direction that could be switched electrically and made to flow with equal facility in a counter-clockwise direction. Thus, the potential for binary storage existed. Nevertheless, these materials were not used because binary storage also required that they support either of two equal and opposite fields exclusively. Instead, they supported an uncontrollable number in either direction. In addition, they all took too long to switch. However, considerable research to improve them was done during the war and they were now ready for a second look.

Aware of this, Dr. Rajchman obtained some improved permalloy and had it formed into small spool-shaped memory cells which he built into a wire grid as described earlier. Needless to say, they worked and established, beyond doubt, the feasibility of magnetic memories for computers. Even so, Dr. Rajchman was not yet satisfied. Permalloy was too expensive and it still switched too slowly. What was needed was a cheaper, faster material. Shortly thereafter, such a material was forthcoming in a special kind of *ferrite* – a man-made substance newly developed in the laboratories.

Combining several metal oxides and traces of other elements, ferrite had been under intensive investigation at RCA and elsewhere for use in communications equipment. At this point, however, its potential as a memory material seemed even more compelling to Dr. Rajchman and he enlisted several colleagues doing materials research at RCA Laboratories to prepare a special batch. They did so in six months. With this he hand-finished several hundred tiny "doughnuts" or cores which worked so well that, later, he had several thousand made and proceeded to build the *Myriabit Memory*, a device capable of storing 10,000 bits of information at one time.

Meanwhile, back at the laboratories, memory research goes on. Coming are micromagnetic, cryoelectric, thin-film and tunnel-diode memories that variously store, process and regurgitate not millions but billions of facts and figures, not in millionths but in ten-billionths of a second.

After that, who knows? With capabilities of this magnitude, perhaps electronic memories will have finally reached a point where the actions and thoughts of space-age man will have nothing left to put in the machines that's worth remembering. ■

NEW HORIZONS FOR MANAGEMENT PLANNING

A combined system of high-speed computers and specially applied computer program "software" provides forecasts for management

SUCH ESOTERIC TERMS as Boolean algebra, flow charts, binary code and "software" are becoming as much an essential part of business terminology as unit sales, cost-per-thousand, and undistributed earnings. The new terms are part of exciting new computer developments for business planning and management decisions.

Now for the first time, as a result, the harried business executive has an unprecedented "view" of his operations as a *total* system.

And, because of the great speed of digital computers, he also has a new freedom to plan and control his business.

"Today, management decision-making faces situations as complex as space shots," says Dr. Franz Edelman, director of operations research for the Radio Corporation of America. "Consequently, computers – the latest business machine 'hardware' – and computer programs, or 'software,' are really as necessary to management as they are to space ventures."

Unfortunately, many executives are more puzzled than pleased by the news that Boolean algebra and electronic digital computers are now at their disposal for practical everyday use.

Mathematics is not new to businessmen.

Neither is Boolean algebra a new development. It derives its name from a 19th century Englishman, George Boole, who viewed logic as a branch of mathematics. Boolean algebra, in short, is the expression of logical analyses in algebraic form.

Boole asserted that logic is *mathematics reduced to two quantities, 1 and 0* – the binary system employed by digital computers. In fact, Boolean algebra makes possible the design of the circuitry for electronic digital computers.

At first, the only benefits felt at the managerial level from electronic digital computers were the improved quality and accessibility of essential data, but this seemed incidental to the main goal of cost-cutting. Yet no management system is any better than the quality of the data it feeds on for whatever purpose – research and development, capital investment, production, marketing or accounting.

When, therefore, it was demonstrated that computers improved the quality and multiplied the quantity of useful business data, a promising new horizon was opened to management. Overnight, enterprising executives began familiarizing themselves with "flow charts".

Unlike the organization chart, the flow chart illustrates the basic operational unity of a company by using a denominator common to all activities – the data flow that circulates throughout it. The result is a picture of the business as a total system ranging from customer orders and production schedules to budgets and board meetings.

Applying computers to company operations has meant developing "software" tailored precisely to the requirements of the company's data flow. This involves a wide spectrum of decisions by management.

"First of all," Dr. Edelman explains, "there are three different classes of applications: data handling, problem solving, and simulation. All three offer business important new advantages."

RCA's Simeral and Bahls check critical path schedule for production project plotted on PERT chart.


MTO INFORMATION

Product blending is a classic example of problem solving. Here, the only management decision may be that product costs should be minimized, subject to certain restrictions on product content. Once that decision is made, the problem of "how" is turned over to a computer program written to handle all alternative cost possibilities. The program is run off by computer to perform perhaps thousands of computations and then print out the solution with the minimum total cost, plus alternative solutions.

"Unlike data handling or problem solving, simulation is primarily useful to top management," Dr. Edelman emphasizes. "Simulation is a planning technique that employs a mathematical model of a company's total business, against which experimental decisions can be tested by the executive."

The value of this simulation technique for corporate planning has been proved repeatedly and can be illustrated by the following hypothetical case:

A month ago the marketing manager for one line of products anticipated a 25 per cent increase in sales next year. The production manager now reports that this forecast necessitates an increase in production staff and facilities, requiring decisions starting next week. What does the company president do?

He can test now for all the consequences of such an order and will be more likely to take advantage of the opportunity reported by the marketing manager. He can also test to see what the value of a 25 per cent sales increase will be after allowing for new investment, added labor costs, and perhaps added marketing costs. Would price changes be desirable? That and many other pertinent questions can be explored in depth before the production manager's deadline for a decision has passed. In short, the president will be able to assess the risk of either agreeing or disagreeing with his marketing and production managers.

"Building a mathematical model is a descriptive problem," Dr. Edelman says. "To resolve it means assembling a complete set of all the logical relationships that make up the company's total business. But where do you start?

"You start at the top of the company's P and L statement with the relationship listed there that defines net profit after taxes. That relationship can be described algebraically without the slightest difficulty. By starting here you are also starting in harmony with the company's own accounting system. This would not be true if you were to try to start at the bottom with, say, random reports of customer orders.

"Then you work down from the P & L statement, always in harmony with the company's accounting system. As each succeeding relationship is identified and expressed algebraically, the descriptive problem becomes more complex. When you are defining the relationship that produces the cost of a sub-product line, for example, you may have to do literally hundreds of computations. However, the validity of the equation can be tested.

"Finally, you may have more than 100 equations that make up the complete series of all pertinent relationships. At this point you face the problem of 'branching' – linking up all the equations to form your mathematical model. Boolean algebra is used for branching. Once branching is completed, you have your mathematical model of the total business expressed in algebraic form."

To translate this model into a computer program, the algebra must be converted into computer code. To assist and speed up this process, the Electronic Data Processing Division of the Radio Corporation of America developed the PROTO-BUILDER.

After computerization is complete, the mathematical model is "verified" by computer runs which compare the output of the model against results based on historical data.

Verification continues until the model responds accurately. Finally, it can be used by management for experimental decision making. But the model builder's job is not finished. For the model must be continually updated by changing the equations for any set of relationships that have changed.

"The concept of experimentation, the essence of the scientific method, is the most important aspect of simulation as a top management tool," says Dr. Edelman. "For years, we have been talking about scientific management, but managers have lacked the tools to apply the scientific method.

"Now, with simulation, the manager has his own laboratory, just as the scientist has a laboratory. Without computers and computer programs, this would not be possible."

The RCA Electron Tube Division, headquartered at Harrison, N.J., employs a computerized model of its business for simulation and to produce its monthly budget reports.

Included in the reports are detailed profit-plan projections for a nine-month future period. To produce these projections, sales forecasts for the division's 17 product lines are used to determine the sales portion of the P & L.

Originally, the mathematical model used by the division was built by Dr. Edelman and Dr. H. Newton Garber of the Operations Research Group in cooperation with Robert E. Higgs, project manager for data systems on the staff of Gaylord C. Brewster, then the division's manager of data systems and services.

"After building the model and verifying it," Mr. Higgs recalls, "we found that the computer program could generate many more lines of useful information than we had ever had before in our monthly budget reports."

Vice President Douglas Y. Smith, general manager of the division, credits the use of the computerized model with discovering essential new facts about the way the division operates.

Tube quality control checks ultimate performance.

"All the detailed work that went into the model forced us to account for many factors that had previously escaped attention at the managerial level," he explains. "As a result, our budget reports now contain new information that is often of critical value for planning and control purposes.

"We successfully and economically employ all three classes of computer applications," Mr. Smith says. "Planning additional uses for all three classes of applications remains a daily responsibility."

An indication of the key role played by computers at the division was the recent promotion of Mr. Brewster from manager, data systems and services, to manager, administrative services of the division.

Data handling applications at the division include a quality control program for tube production.

The use of PERT (Program Evaluation Review Technique) programs to plot critical path schedules for tube production projects is an example of a computer problem-solving application employed by the division.

PERT analyzes all activities necessary to the execution of the project as a series of "events." An event can be described as a point in time, representing either the start or completion of an activity. These are plotted as circles and "networked" by linking them by "vectors" or arrows, indicating units of time. A major purpose of the network is to show which activities can be accomplished in parallel and which cannot take place before another specific event.

When the entire scope of the whole project is networked, the network is computerized by a PERT routine developed for the RCA 501 computer.

"We regularly use PERT for all large projects," says Claire C. Simeral, Jr., manager, microwave tube operations. "It pays off in two ways. First, it forces you to plan completely. Second, it gets the project completed by anticipating avoidable delays."

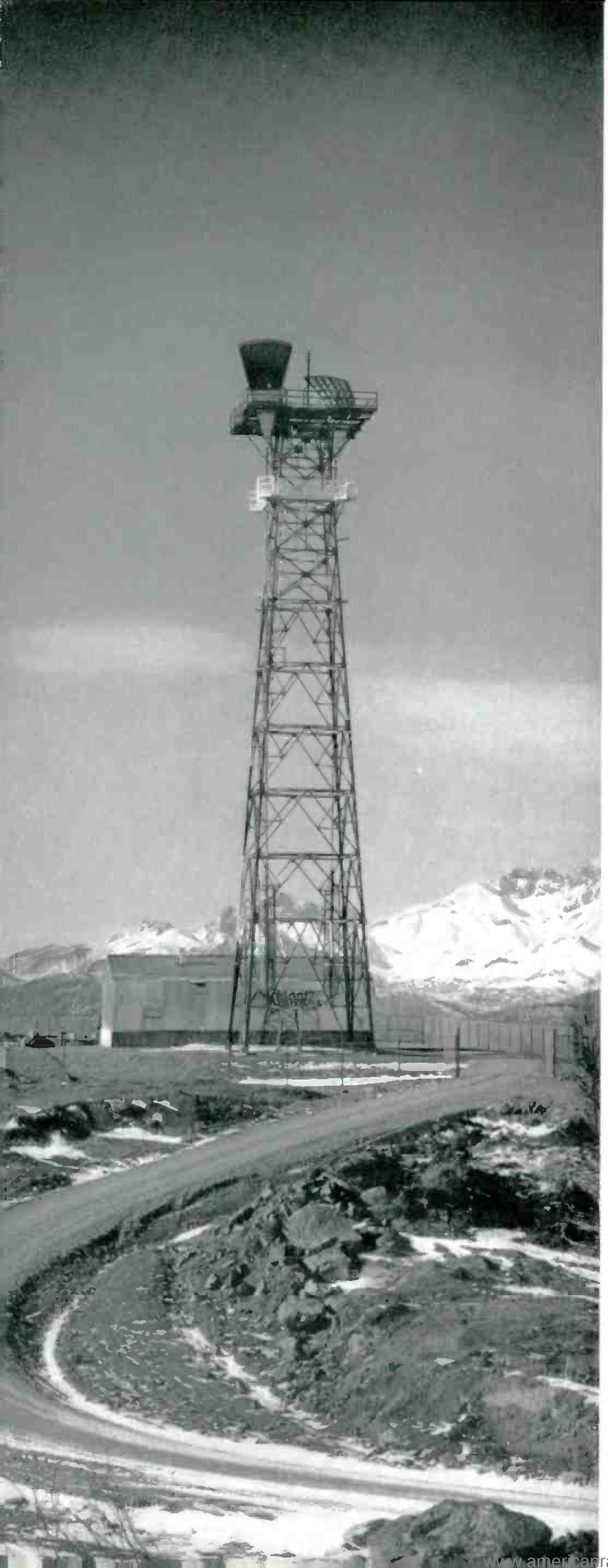
PERT programs cannot prevent the unexpected delay of a schedule caused by fatigued personnel on the critical path, or elsewhere, of a production project. But Dr. David S. Himmelman, of RCA Electronic Data Processing, has recently developed a computer program to test employees for alertness and fatigue.

Dr. Himmelman's program employs measurements of the electric activity of the brain, electroencephalographic (EEG) time series, as indicators of fatigue. These measurements are first plotted in wave forms, then characterized statistically and finally converted to binary code for computer use.

"One result of this program has been to show that standard shifts for all jobs can be a meaningless concept," Dr. Himmelman asserts. "This is, of course, true especially with regard to the growing number of highly-specialized and critical jobs in modern industry."

Dr. Himmelman's program will be employed to test radar operators on the Ballistic Missile Early Warning System (BMEWS) that watches the northern approaches of the Free World for possible missile attack. Its use in private industry is anticipated.

"Electronic digital computers are revolutionizing business management as dramatically and significantly as microscopes revolutionized medicine," says Dr. Edelman. "Computers give new power to management, just as microscopes gave new power to medical science, and they will lead to better management and better managers, just as microscopes have led to better medicine and better doctors." ■



ALASKAN SUCCESS STORY

RCA Institutes trains Eskimos, Indians to man communications and defense networks in Alaska

by Romney Wheeler

ACROSS ALASKA, from Ketchikan to Nome and northward to the Arctic Ocean, invisible networks of microwave and radar communications link defensive outposts of the United States and keep incessant watch on the sky frontiers of the Free World.

There is the Ballistic Missile Early Warning System (BMEWS), guarding against intercontinental missiles. There is the Distant Early Warning (DEW Line) system to spot enemy aircraft. There is the "White Alice" communications system, an intricate network of 65 tropospheric-scatter and microwave stations, providing voice and teletype facilities for both civilian and military use. There are the Federal Aviation Agency's facilities for aircraft navigation and control.

In all, more than 2,500 highly trained technicians are required at scores of Alaskan ground stations to keep some $200 million worth of electronic gear in operation 24 hours a day.

And there's the rub. In Alaska, qualified technicians are scarcer by far than gold nuggets. Generally speaking, they must be recruited elsewhere, in what Alaskans refer to as "the lower 49 states." When recruited, they must be brought to Alaska and – more importantly – they must adjust to extreme conditions of climate and isolated locations.

Thus, the question confronting the Armed Services and the civilian companies operating these facilities under Government contract is: "How do you keep 'em

Microwave station operates in Alaska-Arctic complex.

down on the sites, after their contracts expire?"

Until recently, the answer has been generally negative. The monthly turnover rate of non-Alaskan technicians has averaged four per cent. While projections of this rate might be debatable, even simple arithmetic will show that massive recruitment must go on constantly to fill vacancies resulting when non-Alaskans complete their contracts and go home.

In 1961, a new approach to the problem was proposed by the RCA Service Company, which operates the BMEWS and "White Alice" networks under contract to the United States Air Force. Harold Metz, Division Vice-President for RCA Educational Services, suggested to the Air Force and to the Bureau of Indian Affairs, Department of the Interior, that native Alaskans be trained in basic electronics and employed as technicians wherever possible on the far off Alaskan projects.

Metz argued that native Alaskans – Eskimos, Aleuts, and Indians – could be equipped to hold technicians' jobs if they showed aptitude and were given a chance to take the standard, 18-months resident course at the RCA Institutes, either in New York or Los Angeles.

In presenting his idea, Metz pointed out that there would be many advantages. First, Alaska as a growing state would require more and more technically trained workers for the expanding electronic needs of its civilian population. Second, the Federal Government could save large sums of money annually if the turnover rate of its technicians were reduced. Third, additional savings would result if the Bureau of Indian Affairs could provide greater employment opportunities for its wards, and place them in gainful occupations in the fabric of Alaska's economy.

Happily, the idea found ready acceptance in Washington and, in association with the Bureau of Indian Affairs, the RCA Service Company prepared recommendations for a pilot program. The Bureau of Indian Affairs then selected eight Alaskans – two Eskimos and six Indians – and enrolled them as an experimental group at the RCA Institutes in New York.

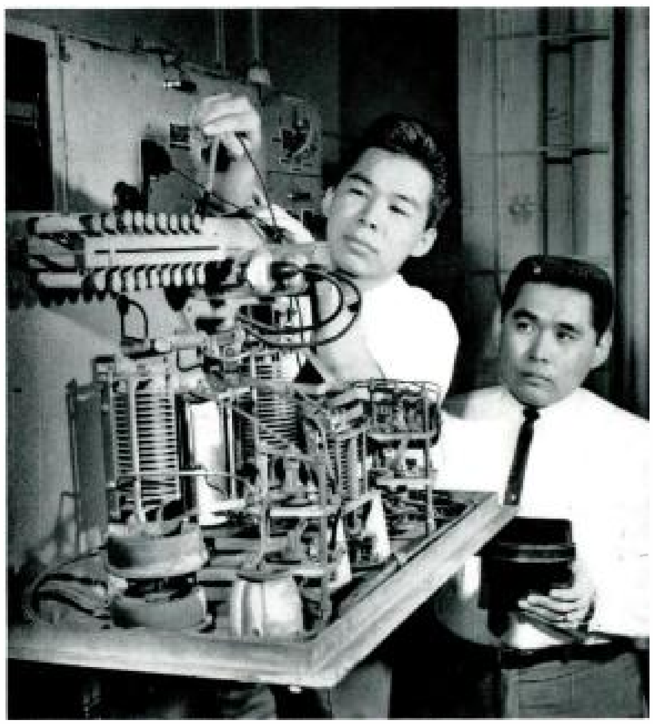
The result was a pedagogical success story that exceeded even the most optimistic hopes of the U.S. Government or the RCA Institutes. The Alaskans completed the difficult course without a single drop-out or failure – exceeding by a considerable margin the performance normally anticipated in this course. Moreover, they did so while making adjustments to daily life in a great metropolis that surely were as difficult for them as the adjustments demanded of non-Alaskans in coping with rugged physical conditions of an Arctic climate and terrain.

Two more Alaskan natives were enrolled in New York a few months later, and another 12 were sent by the Bureau of Indian Affairs to the RCA Institutes in Los Angeles. Each has lived up to the high standard set by the original group, and all are expected to graduate on schedule, at the end of their 18-months course.

The achievement of the first group of Alaskans did not go unnoticed. At the invitation of Alaskan Senators Ernest Gruening and E. L. Bartlett and Representative Ralph Rivers, the students visited Washington August 2 and were received by President Kennedy in the White House Rose Garden.

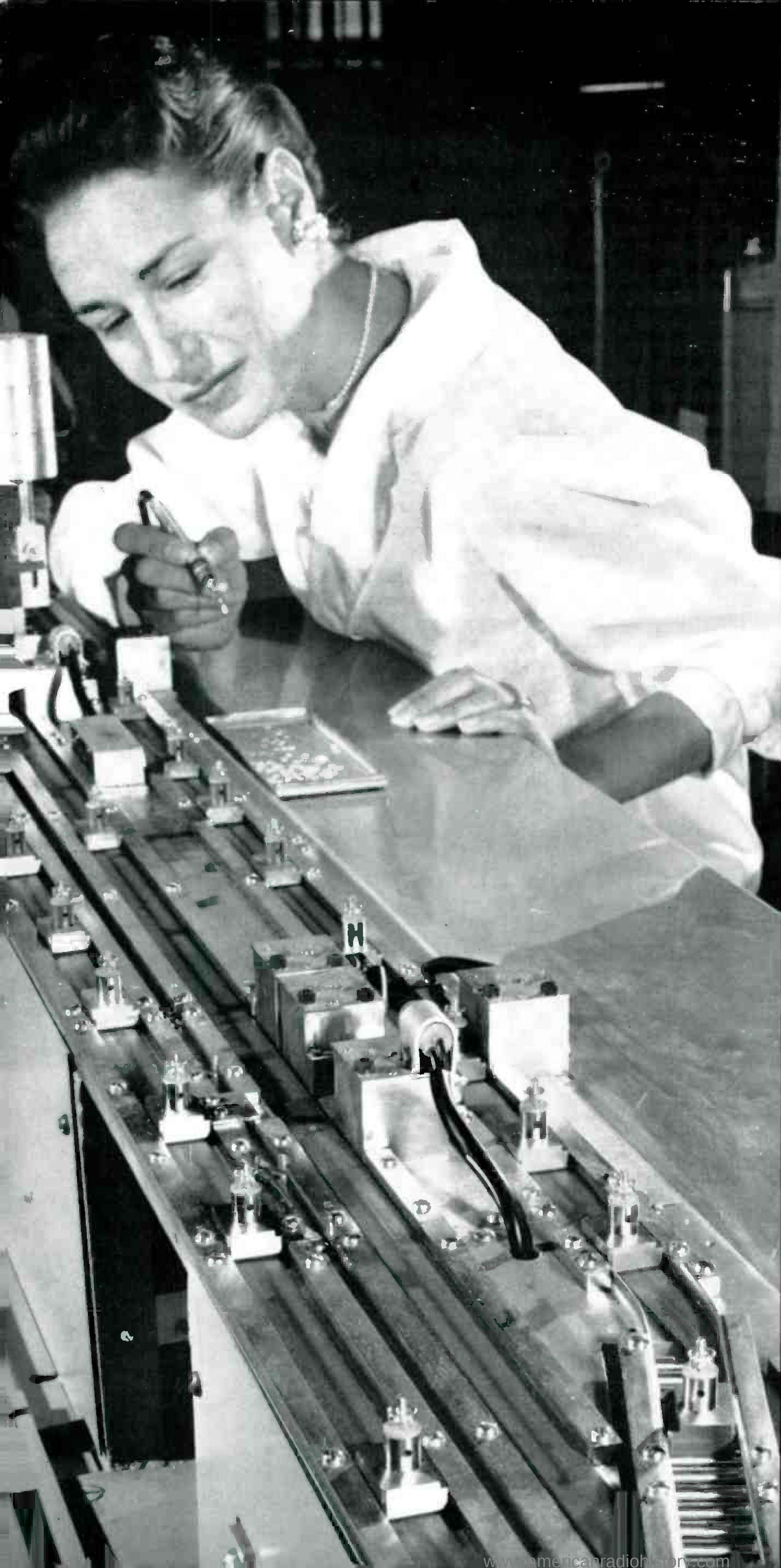
Commissioner Nash explained to the President that, upon graduation from the RCA Institutes, the Alaskans would return to their home state for an additional six weeks' special training in the use of equipment they will find on the sites. All members of the first group are being employed on the "White Alice" communications network, mostly at remote sites in the Northern and Western parts of Alaska. There, upon entering regular employment, the men will receive starting pay and benefits ranging from $9,357 to $10,209 annually.

Pleased with the success of its pilot effort, the Bureau of Indian Affairs is planning to expand its program as quickly as possible. Representatives of the



Alaskans Harry and Sam Kito check transmitter voltage.

Bureau in Alaska were asked to begin screening prospective candidates immediately, with the hope that, by July 1, 1963, they will have selected 125 men who are qualified by aptitude and high school education to be enrolled for the study of electronics. ■



Electronics' Hardy Perennial

**Pill-size or man-size,
the familiar and reliable
electron tube
goes on efficiently
handling everything
from signal amplification
to energy conversion
anywhere from space
to the bottom of the sea**

THE HISTORIAN on the hunt for examples of successful adaptation to a changing environment would do well to consider the hardy perennial of modern technology – the electron tube.

Born in the first decade of the century from the inventive mind of Lee DeForest, the basic three-element tube laid the foundation for a new electronic science that has since become notable for its explosive tendency to supersede the technology which it creates. Through more than half a century of change, the tube has held its key role as a workhorse of electronics, but it has done so by a process of transformation as remarkable as that in the electronic technology which it serves.

Today, the electron tube industry deals in shapes, sizes, and even functions undreamed of by the inventors of yesterday. In size, today's tubes run the gamut from devices no larger than a vitamin capsule to superpower giants taller than a man. They range in price from approximately 50 cents to more than $50,000. Among the industry leaders, RCA itself makes more than 1,300 different types of electron tubes at its plants in New Jersey, Pennsylvania, Ohio, and Indiana.

The tasks performed by tubes in today's electronic apparatus are as varied as the functions of electronic technology itself. For all of their diversity, however, the tasks are variations on a basic theme: i.e., the detection, amplification, or modification of electrical signals in a circuit. Detection, amplification, and control are primary functions of the tube in its most familiar form – the domed glass cylinder that populates the interiors of countless television sets and radios.

The way in which electron tubes operate also can be described as a theme with many variations. Basically, the job is performed by heating a metallic element (a cathode) to the point where electrons are "boiled" out of the material into the enclosed vacuum, and collecting the electrons on another element (the anode). The flow of electrons through the vacuum is controlled – impeded, interrupted, steered, or shaped in any desired manner by electrical fields set up by one or more additional elements (grids) built into the tube.

Working with this basic principle, the art of tube design has created a great array of sensitive and precise instruments that can amplify signals a millionfold or more, transform light into electrical impulses, convert heat to electricity, detect infinitely small changes in light, temperature, or density, and perform a host of other useful functions.

The blending of these useful properties and performance characteristics with painstaking research and engineering has given birth to a modern tube technology that is geared to the swift advance of all electronics in the Space Age. From the floor of the ocean to the moon and beyond, tubes are operating today in a bewildering profusion of types and functions.

Since the dawn of space exploration, tubes have been flying in satellites and with the nation's astronauts. For example, two small pencil-thin electron tubes powered the voice radio broadcast of Astronaut John Glenn during his historic orbital flight in the Friendship 7 spacecraft. Gold-plated, two-ounce tubes powered the transmission of signals across 8 million miles of space from the Pioneer V vehicle in May, 1960, spanning the greatest distance in radio history up to that time. Both of these examples refer to special tube types produced by RCA's Electron Tube Division for application in the rugged environment of space.

One of the key functions of modern-day tubes is the translation of optical information to electrical signals for transmission – the pickup function of television. One of the keystones of present television broadcasting is the famed image orthicon tube used for both black-and-white and color pickup. But for many television applications, in space, military, and industrial functions, the image orthicon is too large for operation in compact equipment. For these functions, tube technology has produced a small and rugged pickup device known as the vidicon.

The extremes to which the vidicon has stretched television's capabilities are neatly illustrated by two recent examples. Four one-inch-diameter vidicons were recently installed in an underwater vehicle developed by the U.S. Navy to crawl along the ocean floor. Through these electronic eyes, cameras in the vehicle can relay ocean-bottom pictures through a five-mile length of cable to a monitoring and control station on land.

In smaller dimensions, approximately the length and diameter of a filter-tip cigarette, vidicon tubes have provided the "eyes" of the famed TIROS weather satellites developed by RCA. In each of the six TIROS vehicles, two vidicon cameras have provided a new look at the world's weather from space, shedding new light on the weather patterns around the globe and furnishing comprehensive data for improved forecasting service.

Electron tubes are on military duty by the millions. At giant arctic radar outposts, display storage tubes show the approach of unidentified aircraft or ships as small "blips" or flashes of light on a radar screen.

One unique tube called the image intensifier orthicon can actually "see" in the dark. During a recent night amphibious operation at Fort Story, Va., the tube enabled observers, located at a remote point, to watch a mock "enemy" landing on TV monitors. Military personnel reported that they could clearly detect men in boats approaching the shore line and could see other boats as far out as the third landing wave.

Technician checks automatic device installing main assembly of nuvistor tubes in production.

Aside from their use in military communications, electron tubes are employed extensively for several types of countermeasures systems which are designed to impair the effectiveness of enemy electronics, such as radar. Still others are utilized in counter-countermeasures equipment that decreases the effectiveness of enemy counter-measures. Devices in the category of traveling-wave tubes are presently at work in microwave systems that increase and extend the range of radar and amplify signals of satellites.

During 1959, RCA unveiled a revolutionary development in electron-tube design. Called the "nuvistor", this thimble-size tube has made possible important contributions in the design of compact and efficient electronic equipment. In conceiving the nuvistor, RCA engineers put aside many traditional tube-making methods, materials and structures. They sought to develop a new approach that would eliminate some of the common causes of tube failure such as the use of mica, glass, and spot welding. The result was a rugged, ceramic-metal device that was specifically engineered for high-speed mechanized production.

"Nuvistorized" is now a common term in the electronics world to refer to apparatus that employs these small tubes. Aside from their use in TV sets, nuvistors are setting new high standards of performance in the circuitry of the Nimbus weather satellite TV camera, electrocardiographs, portable UHF transmitter-receivers, engine analyzers, test instruments, radio equipment and military devices. The tiny nuvistor tube also contributes to a new instrument called an "artificial mastoid" which measures the intensity of vibrations produced by a hearing aid. In addition, the nuvistor's exceptional technical characteristics also make possible improved TV reception.

Tiny tube operates in radio transmitters of weather ballons at 19-mile altitudes.

Tube-making ingenuity was demonstrated further by the development of a half-size nuvistor for the U.S. Navy Bureau of Ships. The reduced size tube, one of the smallest ever made by RCA, is no larger than a vitamin capsule. It is expected to be evaluated for use in anti-submarine warfare equipment, aircraft-proximity warning systems.

At the other end of the spectrum are super power tubes, several of which tip the scales at 250 pounds. These electronic giants serve as the backbone of television broadcasting, strategic military radar and particle accelerator fields.

One RCA super power tube has just been installed as a key component in the $11.6 million Cambridge Electron Accelerator at Harvard University. This instrument, the world's most powerful electron accelerator, has produced an energy level of six billion electron volts. Sponsored by the Atomic Energy Commission, the accelerator will extend man's knowledge of nuclear forces beyond all present frontiers.

The ceramic-metal tube which will aid the accelerator in achieving these remarkable feats was custom built by engineers at the RCA's Lancaster, Pa. tube plant. Called a super-power triode, it weighs 200 pounds and is water cooled. The price of this electronic giant is approximately $57,000.

A 150-pound klystron amplifier tube which can deliver 24 million watts peak power has been designed for the two-mile linear accelerator of Stanford University. This tremendous power from these klystron tubes drives electrons through a 4-inch diameter accelerator tube at approximately the speed of light to aid in the study of particles and measurements of nuclear structures.

Another super-power tube, named the Coaxitron, was recently developed by the company in cooperation with the U.S. Air Force. Certain electrical characteristics of this tube permit greater effectiveness of a radar unit in the face of enemy counteraction.

Electron tubes also serve important functions in many diverse fields of science. Some 50 different tubes are used in the operation of the RCA electron microscope which has made significant discoveries in medicine and industrial research. The dread polio virus was seen for the first time with this powerful instrument and protective vaccines were developed with its assistance. Incredible as it may seem, the electron microscope can be used to view and photograph objects 1,000,000 times thinner than the thinnest human hair.

The "ultrascope" is still another example of RCA

Vidicon tube above televises world's weather from TIROS satellite. Background photograph is typical picture from TIROS.

tubes that assist medical research. This particular device, which is the "eye" of a simple attachment for a conventional microscope, permits direct visual focusing of an image under ultraviolet light. It converts invisible ultra-violet images of specimens into visible pictures that can be interpreted for diagnosis. During the last few years, the ultrascope has been used for important studies at the National Institutes of Health.

In astronomy, devices known as cascaded image tubes are at work in obtaining new knowledge about very faint stars. With the aid of such tubes designed for operation at very low light levels, stars many light years away can be photographed in 1/100 of the time normally required.

A tube less than ten inches long serves as the electronic shutter for the world's fastest camera. This image-converter tube aids a special camera to make photographs with shutter speeds as fast as 2½ billionths of a second. Thanks to the tube and the new camera, scientists can make pictures never before possible for plasma-physics research.

Perhaps one of the most remarkable products of modern electrical engineering is the famous RCA color television picture tube. Over 1,071,000 tiny phosphor dots are precisely positioned on the inside face of this tube. Modulated beams from three electron guns in the neck of the tube pass through a special mask to make various phosphor dots glow. Light from these dots blend to provide every shade of color desired.

New developments in the electron tube art never cease. A year ago, RCA engineers devised a special gray insulation coating used for the "heater" wire inside an electron tube. This so called "dark heater" greatly extends the life of tubes and improves their performance in radio and TV sets.

Describing challenges confronting the electron tube industry, Douglas Y. Smith, Vice President and General Manager, RCA Electron Tube Division, recently said:

"Our industry has always been in the fortunate position of having challenges to face and competition to meet. . . . We in the electron tube industry welcome these challenges. They spur us on to greater efforts and greater accomplishments. Startling new tubes are warming up on the sidelines as fast as demands of the Space Age create a need for them." ■

ELECTRONICALLY SPEAKING

RETURN OF A VETERAN

A World War II veteran went into action 1,800 miles west-northwest of Honolulu to perform the essential mission of tracking and data-collecting for the National Aeronautics and Space Administration (NASA), to pinpoint the spot where astronaut Walter Shirra's capsule came down after his historic, six-orbit flight of the earth for the Mercury Program this fall.

The veteran is a vintage Liberty ship (christened, *American Mariner*) that has become the DAMP (for Down-Range Anti-Missile Measurement Program) ship – a veritable floating laboratory of electronic equipment.

The DAMP ship has been in service for three-and-a-half years on the Atlantic and Pacific missile ranges for the Program, which is part of the Advanced Research Project Agency's project Defender and is conducted for various government agencies and operated by RCA under contract to the Army Missile Command.

The DAMP ship, according to S. N. Lev, Division Vice President and General Manager of RCA's Missile and Surface Radar Division, "has no peer among missile and space tracking ships. It is the most scientifically advanced now in operation anywhere in the free world."

THE $57,000 KEY

A whopping new RCA super power tube costing about $57,000 is one of the key components in the Cambridge (Mass.) Electron Accelerator designed by Harvard University and MIT scientists.

The purpose of the accelerator is to produce much higher energy electrons and protons than ever before available in large quantity.

RCA's new super power triode tube was built especially for the six *billion* volt accelerator. A ceramic-metal tube, it weighs about 200 pounds and is water-cooled.

THE BIG HOP

A unique microwave system using a different frequency for each of its three hops is bouncing network television programs over a 137-mile path from KRCS (Los Angeles) to KOGO-TV (San Diego).

The whole point of the different frequencies is to dodge adverse signal conditions for the most reliable service possible.

Outbound from Los Angeles, the TV signal takes an interesting trip. It shoots to Mt. Wilson on the first leg; then on a hop of 108 miles that includes 40 miles of Pacific Ocean to the Mt. Soledad station's 19-foot dish and finally down to the San Diego studio.

ELECTRONIC PRINTER'S DEVIL

RCA's 301 Electronic Data Processing System has moved into the print shop with its electronic brain. The computer takes over line justification; trims typesetting time as much as 40 per cent and can handle newspaper payroll and other financial paperwork as well.

The RCA computer-typesetting system centers around an RCA 301 Electronic Data Processing System into which are fed specially compiled vocabularies and electronic instructions to compose lines of type adjusted to newspaper column width. In the average newspaper composing room, type is set either through manual operation of the line-casting machine keyboard or through use of perforated paper tape to activate the machine.

The paper tape must be prepared by specially trained operators who perform the line justification function. Under the RCA plan the 301 accepts paper tapes prepared by typists without special training, taking over the justification chore.

DATA BONANZA

The London offices of Socony Mobil Oil Co. can expect a flood of data from the New York offices greater than any gusher.

The company is the initial user of a high-speed service for international computer users called Datatelex. The service was inaugurated this fall between the U.S. and England by RCA Communications, Inc., for the oil company.

Datatelex makes available on a demand or time basis a means by which data in any form – magnetic tape, punched cards, or paper tape – may be transmitted overseas at high speeds of approximately 1200 bits per second or 1500 words per minute.

At right, a communications operator for Socony Mobil Oil Co. examines a strip of punched tape used for transatlantic communications.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"Mark 8" Color TV costs as little as $495—manufacturer's nationally advertised price, optional with dealer—for Fraser, not shown. Slightly higher some areas West, South. UHF optional extra. Prices, specifications subject to change

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